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EXPERIMENTS and OBSERVATIONS

ON

AMERICAN POTASHES.

WITH

An eaſy Method of determining their reſpective Qualities.

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OBSERVATIONS

ON

AMERICAN POTASHES.

THE eight sorts of Potashes sent to me by the society are all of a dark colour, some almost black; some have a reddish cast, and others appear on breaking of a cherry or rose red, which soon changes to a dusky hue on being exposed to the air.

They are all compact, hard, and slow of solution: though they soon liquefy on the surface, they do not readily dissolve, even by boiling in water, unless reduced to powder.—Some other sorts of Potashes from *America*, which were sent to me for examination about a twelvemonth ago by persons concerned in the trade, are much whiter, more friable, and easier of solution.

Some of these Potashes have a considerable degree of causticity, though none of them so much as the other sorts above mentioned. The workmen I have consulted complain, that the causticity of the *American* Potashes in general is so great, that the skin and clothes are often corroded by the fragments, which fly about in breaking the hard masses.

Lyes made from thefe Potafhes with cold water are fufficiently pale, the colouring matter remaining undiffolved: lyes made by boiling in water are deep coloured at firft, but foon depofite a dark fediment, and become pale as the others: The lyes of fome of them, though well loaded with the falts, are colourlefs as water.

Several of thefe lyes, though of little colour themfelves, give a black ftain to filver, tin, and copper: the filtered liquor by being boiled in a tin pot became alfo blackifh: on ftanding, the black matter precipitated, and the clear lye no longer difcoloured the metal.

On adding an acid to the lyes, fome contract a flight untranfparence, and yield a fetid fmell like that of the wafhings of a gun-barrel: others retain their tranfparency, and give little or nothing of this fmell. It is probable, that both the fmell and ftaining quality depend upon one caufe, an impregnation of fulphureous matter.

To determine the quantity of falts in thefe Potafhes, four ounces of each of the forts were boiled in water, the folutions filtered, and the refidue on the filters wafhed with frefh portions of boiling water, till the water paffed through taftelefs. The folutions were boiled down feparately in an iron pot, and the falts continually ftirred and fcraped from the pot as they became dry. Moft of the falts, after being kept for fome time in a moderate heat, below red-hot, appeared pretty white, fome with a yellowifh, fome with a greenifh, and fome with a dufky greyifh caft; fome of them were difficultly dried, and after they had become dry, feemed difpofed to melt. The falt which had

this

this property in the greateft degree, was that of the Potafh which feemed the moft cauftic, marked A A. The quantity of falt from moft of them was about three ounces, and $\frac{1}{3}$ of an ounce. The loweft yield, *viz.* from E, was $3\frac{1}{6}$ ounces; and the higheft, *viz.* from B $3\frac{3}{5}$, from four ounces of the Potafhes.

Thefe Potafhes appearing to be all fufficiently rich in falt, I endeavoured to difcover by cryftallization whether they contained any other kind of falt than their proper alcali. Four ounces of each of them being elixated as before with boiling water, the filtered folutions were evaporated to fomewhat more than half a pint each, and fet to cool in ftone bafons. A confiderable portion of falt fell to the bottom in all, though pure alcaline falt would not have feparated from fuch a quantity of water. The falt from G was in largeft quantity; and was therefore made choice of for further cryftallization.

This falt difcovering to the tafte that it retained much of the alcali, it was cautioufly wafhed with a little cold water, and this put to the reft of the lixivium. More cold water being added to the falt, great part of it diffolved by ftirring and fhaking, fome very difficultly; a part remained undiffolved, which felt gritty like fand, and tafted bitterifh like vitriolated tartar. The folution being filtered and fet to evaporate in a ftone bafon with a gentle heat, a pellicle formed on the furface, and fome falt fell to the bottom in fine powder; in cooling more falt fell in fmall grains like duft. The liquor, which tafted alcaline, being poured off, the falts were again diffolved in water: in evaporation the

ſame ſeparation happened of a ſalt in fine grains, which ſeemed to be vitriolated tartar; and on cooling large cryſtals formed, not unlike ſea-ſalt, but extremely tender, and ſtill ſomewhat alcaline to the taſte; a little quantity of the moiſt grains held over the fire in a ſilver ſpoon, liquefied before the ſpoon could be perceived to be warm, and dried into a white powder, which taſted like a mixture of ſea-ſalt with a little alcali and vitriolated tartar: the powder being put on the point of a knife, great part of it melted juſt as the knife became red-hot; ſome grains remained unmelted.

It appears from the above experiment, that the ſalts of theſe Potaſhes are not purely alcaline, but contain a mixture, ſome of them a very large one, of ſalts of another kind; but the perfect ſeparation of theſe foreign ſalts by cryſtallization, either from the alcali or from one another, eſpecially when the proceſs is performed with ſmall quantities of the matter, was found ſo difficult and tedious, that the enquiry was dropt, and another way of examination tried.

Having extracted the whole of the ſaline matter from the ſeveral Potaſhes, it was judged that the quantity of true alcali in the ſalts might be diſcovered by their power of ſaturating acids, compared with that of an alcali of known purity; and this method ſucceeded ſo well, that it is hereafter propoſed for the aſſaying of Potaſhes, and the manner of procedure deſcribed at large. It was thus found that of the ſalt extracted from the Potaſh G, more than one third part is not alcaline.

According to theſe experiments, the quantities of ſalt contained in a pound or ſixteen

ounces

ounces of the ſeveral Potaſhes, and the quantities of alcaline and foreign ſalts of which the ſeveral ſalts conſiſt, are as follows :

	Ounces of ſalt.	Ounces of alcali in the ſalt.	Ounces of ſalt not alcaline.
A	$13\frac{7}{10}$	$11\frac{7}{10}$	2
AA	$13\frac{4}{10}$	$12\frac{5}{10}$	$\frac{9}{10}$
B	$14\frac{4}{10}$	$9\frac{8}{10}$	$4\frac{6}{10}$
C	$13\frac{6}{10}$	$11\frac{3}{10}$	$2\frac{3}{10}$
D	$13\frac{7}{10}$	$11\frac{4}{10}$	$2\frac{3}{10}$
E	$12\frac{8}{10}$	$10\frac{4}{10}$	$2\frac{4}{10}$
F	$13\frac{6}{20}$	$10\frac{9}{10}$	$2\frac{7}{10}$
G	$13\frac{7}{10}$	$8\frac{3}{10}$	$5\frac{4}{10}$

Obſervations on the American *proceſs of making Potaſhes.*

TO judge how far the hardneſs and ſlowneſs of ſolution, the cauſticity, ſtaining quality, and foreign ſalts, of the *American* Potaſhes, might depend on the circumſtances of their preparation, or deſigned abuſes, I procured from different perſons converſant in this manufacture, the beſt information I could of the method of making Potaſhes in *America*, and repeated the proceſs myſelf.

There is very little wood burnt on purpoſe for this work, greateſt part of the Potaſh being made from the aſhes of wood burnt in common chimneys for domeſtic uſes. The woods chiefly employed are the hickery, oak, beech, birch, elm, walnut, cheſnut, and maple : different ſorts are burnt together, old and young, green and dry ; and if one ſort ſhould ſometimes be burnt by itſelf, the aſhes are not kept ſeparate, but put to the ſame heap with others. It is ſaid by ſome that a ton of Potaſh is obtained

 from

from 400 bufhels of afhes; by others from 450 bufhels; by others from 560 of the beft afhes, and double that quantity of the worft, moft commonly from 700 bufhels; fome think that the beech yields moft falt, others that the oak yields moft, and the walnut leaft; but that the difference is not great.

The afhes are collected from the country people in winter, and laid in heaps under fheds, or in other convenient covered places, till May or June; not that they are fuppofed to be any ways improved by keeping, but becaufe the Potafh manufacture is carried on during the fummer only, the froft rendering the elixation impracticable in winter; at the time of ufing, they are moiftened with water, or weak lye, to lay the duft.

The lye is made from the afhes in backs or vats, the dimenfions of which are faid to be 8 feet by 10, and 18 inches deep; and three of them which are fet at once, to hold 500 bufhels. As three veffels of fuch dimenfions are fcarcely equal in capacity to 300 bufhels, the afhes muft either be rammed down hard, or heaped above the fides, or both. Some water is poured on the top, and as faft as it foaks in, more water is put on. According to fome, the water is fuffered to ftand for a week on the afhes; according to others, it is not ftopt at all, but runs out as foon as it has penetrated to the bottom in a fmall ftream of a dark-brown, or chocolate colour. They continue putting more water on the afhes, till, by the colour and weight of the lye, it is judged that all the falt is extracted. The firft lyes, and as is thought the fecond alfo, are conveyed into a ciftern to be boiled down, the

the others are reſerved to be poured on freſh aſhes.

The lye is boiled down in iron pots, ſome of which hold 60 gallons, though many are leſs, and ſome are ſaid to be ſo large as to hold 80 gallons. Two pots are hung together in brick-work in ſuch a manner, that the fire acts upon the ſides as well as on the bottom. The bottoms are ſubject to crack or ſplit. It is ſaid that ſome perſons in *America*, having contrived to caſt them with the bottoms downwards, ſo that the bottom is formed of the heavieſt and moſt ſolid part of the metal, this inconvenience is in good meaſure prevented.

As the lye evaporates, more is laded in, a gallon or two at a time, till the pots are judged to have a ſufficient charge of ſalt. The ſalt, in becoming dry, grows ſo hard, and ſticks ſo firmly to the ſides and bottom of the pot, as not to be got off without much labour; but accident has lately diſcovered to the manufacturers a method of avoiding this moſt troubleſome and tedious part of the proceſs. Inſtead of waiting till the pots are grown ſomewhat cool, and getting out the ſalt with mallets and chiſels, as formerly practiſed, they increaſe the fire till the pot becomes red-hot and the ſalt melts; in which ſtate it is conveniently taken out with iron ladles, and caſt either on a dry floor, paved on purpoſe, or in old iron pans. Before fuſion, the ſalt is brown; in fuſion it turns of various colours, blackiſh, reddiſh, *&c.* Some ſuſpect that a little common ſalt is added to make it melt more eaſily.

I performed this proceſs with ten buſhels of aſhes procured from ſome farm-houſes, where oak,

oak, birch, aſh, elm, and hazel are burnt. The aſhes were put into two tubs, which had falſe bottoms covered with fern and hair-cloth, ſupported by pieces of bricks above the true bottom. Being rammed pretty cloſe to the ſides to keep the water from ſlipping down between, and a cavity being formed in the middle, ſome water was poured gently on the aſhes in one of the tubs, and more water added as faſt as it ſoaked in. In about two hours the liquor had penetrated to the bottom, and began to run out of a deep brown colour: we continued putting on more water, and examined the ſtrength of every pail-full of the lye by an hydrometer, which will be deſcribed hereafter. The firſt pail appeared to hold about three quarters of an ounce of ſalt on the pound avoirdupois; the ſecond pail near $1\frac{1}{4}$ *oz.* the third above $1\frac{1}{2}$, the fourth and fifth $1\frac{3}{4}$, after which the ſtrength gradually diminiſhed. When the lye run weak, it was ſtopt, and ſuffered to ſtand ſome days on the aſhes, by which its ſtrength was increaſed from $\frac{1}{4}$ to above $\frac{1}{2}$ an ounce on the pound. It appears therefore to be of advantage to let the water ſtand ſome time on the aſhes. The above lyes being paſſed ſucceſſively through the ſecond tub of aſhes, the firſt pail appeared to hold $2\frac{1}{4}$ ounces of ſalt on the pound; the ſecond nearly the ſame; the third ſomewhat leſs than two ounces. It ſhould ſeem therefore unfrugal to carry any of the firſt lyes to the boiler, as their ſtrength is ſo greatly increaſed by paſſing through freſh aſhes.

All the above lyes that ſeemed of moderate ſtrength were mixed together, boiled down in a large copper to about one third, and then laded

laded by degrees into iron pots, placed in proper furnaces, till the quantity of falt in the pots was as great as could conveniently be dried in them. One pot charged with feven or eight pounds of the dry falt, was hung in the furnace by its rim: the falt melted, but not before the rim of the pot became red-hot, a kind of crufty matter continuing unmelted on the furface, probably from the contact of the air: the fluid falt laded out into another iron veffel, concreted into a hard, compact, dark-coloured mafs, which eafily came out of the veffel on turning it upfide down, and greatly refembled fome of the *American* Potafhes: the mafs being broken, feveral of the pieces turned in a fhort time whitifh on the furface. Some of this Potafh was put into the fame pot, with an addition of $\frac{1}{16}$ of common falt: it melted much eafier than without the common falt, this laft coming firft into fufion, and diffolving the other; a cruft ftill formed on the top: when cold, the furface was of a brownifh green colour, but in a day or two turned white. The fame quantity of the Potafh, in a large iron crucible placed among the fuel in the fame furnace, flowed thinner than in the foregoing circumftance, but ftill contracted a cruft on the top, though lefs thick; and on trying fome of the *American* Potafhes, they gave the fame appearance. Ten pounds of our Potafh were kept in fufion with a ftrong fire for two hours, and the cruft continually broken and pufhed down; part continued to rife again, and was at length fcummed off; part feemed to have fettled to the bottom, for on lading out the fluid falt, an unmelted matter remained behind; fo that though the

cruſt may proceed in part from a portion of the ſalt cooled by the contact of the air, it ſeems alſo that a part of the earthy ſubſtance of the Potaſh is thus thrown off. By this continuance of fuſion the Potaſh did not become at all whiter: it inclined in ſome places to purple, broke more eaſily than before, and appeared of a large broad granulated texture.

This Potaſh agrees with the *American* in ſlowneſs of ſolution, apparently from the compact texture occaſioned by the fuſion.

From the ſame cauſe theſe melted ſalts are very difficultly, if at all, convertible into a good pearl-aſh by the common proceſs of calcination. Several pieces both of the *American* and my own, about the ſize of walnuts, were placed under a muffle, open at both ends, ſo contrived that the fire lay all on its upper part. The Potaſhes were kept for upwards of ſix hours of a ſlight red heat, ſo as juſt not fully to melt, and occaſionally turned and moved to more or leſs hot parts of the muffle, and the flame of wood ſuffered at times to paſs over their ſurface; ſeveral of the pieces became ſmooth and greeniſh on the outſide; but on breaking, they did not appear altered in any reſpect. Some pieces of the cruſt that had been ſcummed off in the fuſion of the Potaſh, being leſs diſpoſed to melt than the reſt, contracted no ſmoothneſs or gloſſineſs; they became white, but not to any conſiderable thickneſs.

Theſe ſalts receive from the fuſion one valuable quality. Their oily matter being burnt to an indiſſolvable coal, they give a pale or colourleſs lye; while thoſe which have not ſuffered fuſion

ſion or a red heat, give always a brown or deep-coloured lye.

This Potaſh agrees alſo with the *American* in ſome other properties, which might leſs be expected. Solutions of it ſtain ſilver, and yield a fetid ſmell on the addition of an acid. The quantity of pure ſaline matter obtained from it, is ſomewhat leſs than thirteen ounces on the pound; and of theſe thirteen ounces, two ounces or more appear from the trial with acids to be a foreign ſalt; ſo that it is nearly of the ſame degree of impurity with the *American* Potaſhes, C and D.

The impurity of this Potaſh is eaſily accounted for from the common ſalt, which the aſhes of kitchen-fires cannot fail to partake of. But as the quantity of wood burnt in the *American* colonies during the winter, is doubtleſs far greater in proportion to the number of people, and conſequently in proportion to the quantity of proviſions dreſſed, than in our farm-houſes; the *American* Potaſhes cannot be ſuppoſed to be affected by this cauſe in an equal degree with ours. It may be preſumed that ſeven ſorts out of the eight before examined have a deſigned addition of the ſea-ſalt; more eſpecially as the remaining one A A, was found to contain not half ſo much as any of the others. In two of them, B and G, the quality of the foreign ſalt is ſuch, that there are grounds to believe that ſea-water has been uſed inſtead of common water for making the lye from the aſhes.——As almoſt all the common ſorts of ſea-ſalt participate of the ſalt of the bittern of the ſea-water, the combination of the vitriolic acid of that ſalt with the inflammable matter, during fuſion, is pro-

bably the origin of the ſulphureous taint, both in the *American* Potaſhes and mine.

There is one property in ſeveral of the *American* Potaſhes, cauſticity, which I do not conceive to be communicable by any circumſtance, either in the proceſs itſelf, or that can happen to the aſhes of common fires, without a deſigned addition. The above Potaſh from farm-houſe aſhes, and a ſalt which I prepared on purpoſe from bakers aſhes, had no cauſticity, either when the lye was ſimply evaporated to a dry brown ſalt; or when this ſalt was melted into a black maſs; or when it was calcined to perfect whiteneſs; or when the ſalt was extracted by water from the black maſs, and again boiled down to dryneſs; the ſalts in all theſe ſtates ſeeming to be as mild as common ſalt of tartar. It may therefore be preſumed, that the cauſticity of the *American* Potaſhes does not proceed from the manner of their preparation, but from an addition of quicklime.

It is affirmed by Dr. *Brandt*, in the *Swediſh* tranſactions, that vegetable aſhes themſelves may be converted by fire into a true quicklime, ſoluble in water like the common quicklimes, impregnating it with the ſame taſte, and giving the ſame cauſticity to alcaline ſalts. I therefore took ſome bakers aſhes, from which all the ſalt had been extracted that could eaſily be got out with warm water, and kept them red-hot in a crucible for an hour: being then put into water, they did not impart to it any taſte, or any of the common properties of lime-water. Another quantity of the aſhes was kept in a ſtronger red heat for two hours; they communicated to ſo much water as juſt covered them,

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a tafte like that of very weak lime-water, and the liquor became milky, as lime-water does, on dropping in an alcaline lye. Another portion of the afhes was kept for two hours in fuch a heat, that the part next the bottom of the crucible melted into a kind of femi-tranfparent glafs: the upper part baked into a dark-coloured friable mafs, gritty like fand, which gave to water a tafte like that of pretty ftrong lime-water. This liquor contracted a fkin or thin cruft on the furface, and grew very milky with alcaline lye, but did not fuffer any change of tranfparence, as the common lime-waters do, from vitriolic acid.

It appears therefore, that though vegetable afhes may be brought by fire to have fome of the properties of quicklime, and though in this ftate they fhould be capable of giving fome caufticity to alcaline falts, yet they do not become perfectly the fame with the common quicklimes; and the degree of fire neceffary for producing this change is fuch, that the falts of common chimney-afhes cannot be fuppofed to receive any caufticity from this caufe.

General obfervations relative to the affaying of Potafhes.

THE beft Potafhes contain always fome quantity of indiffolvable earthy matter; fome of thofe which have been long ufed in certain bufineffes, as the *Ruffian*, a very large one. What proportion of vegetable earth may be allowable in good Potafh, and what proportion fhall be deemed to render the commodity unfit for market, I cannot pretend to judge. Perhaps it

it may be advifable to allow a very confiderable latitude, and to affix proper marks on the tubs, that their value may be known.

As all Potafhes, thofe at leaft which are made from the afhes of kitchen-fires, muft be expected to contain marine falt, a latitude muft be allowed alfo in this refpect. A fmall proportion of fea-falt can fcarce be fufpected of being very injurious in the bufineffes where Potafhes are chiefly employed : a large one may be of real detriment, independently of the confumer being defrauded by it of the due quantity of alcali. Dr. *Home* relates, that in bleaching of linen, fea-falt mixed with the Potafh injures the cloth, by opening, thinning, and weakening it ; and that fome fkilful bleachers have rejected a Potafh, which according to his account does not contain fo much fea-falt as two of the *American* forts above examined.

The fulphureous taint or ftaining quality, which feems, as already obferved, to proceed from the vitriolic falt, of which almoft all the common forts of fea-falt participate, will probably be of more general injury than the pure marine falt; and therefore Potafhes, which have this impregnation in a great degree, may deferve to be condemned, or at leaft ought to be properly diftinguifhed. An experiment already mentioned gives room to hope, that low degrees of this taint may be remediable, or that the ftaining matter may be feparable by certain additions.

Different lumps of Potafh taken out of one tub, and the top and bottom parts of the quantity melted in one pot, differ both in appearance and quality. This difference was fufficiently fenfible, even in the fmall parcels of the

feveral

ſeveral ſorts of Potaſhes ſent to me. The ſame precaution therefore ought to be uſed here as in the aſſaying of certain ores: pieces ſhould be broke off from the moſt diſſimilar lumps in different parts of the tub, to the quantity of half a pound or more; all the pieces reduced to powder together in a dry and warm mortar; and the quantity neceſſary for the aſſay taken from this powder; or if this is too troubleſome, the aſſay quantity ſhould at leaſt be taken from ſeveral pieces, never from a ſingle one.

Habit will enable an attentive obſerver to form ſome judgment of certain qualities of Potaſhes, from the appearance of the maſs, or from the operations, which are only preparatory to the direct aſſay. In making a ſolution of the Potaſh in water, he can judge in ſome meaſure by the eye, whether it contains very little or very much indiſſoluble earthy matter. If any ſand has been mixed with the Potaſh, the ſand will ſettle firſt, and may be eaſily known by its grittineſs; the pale or high colour of the lye will ſhew whether the oily matter has been ſufficiently burnt out or not; and a piece of bright tin dipt for a little while in the liquor, will diſcover any injurious degree of ſulphureous taint.

Of diſcovering marine or other foreign ſalts mixed with Potaſhes.

IT is obſerved in the aſſaying of ores, that the alcaline flux and ſea-ſalt, put into the crucible, do not unite in fuſion, the ſea-ſalt floating upon the ſurface of the other, and forming, when cold, a diſtinct cake. It was hoped that

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on this principle, sea-salt mixed with Potashes, might be separated and obtained distinct by simple fusion. In a variety of experiments made with the *American* and my own Potashes, and with known mixtures of pure alcali and common salt, with and without inflammable additions, the separation was sometimes very manifest, sometimes not perceptible, and no where so perfect as to fully answer the intended purpose.

Another property of the marine and other neutral salts, of being thrown down from their solutions by spirit of wine, while the proper alcaline salt of Potashes continues dissolved, promised better success. A saturated solution of pure alcaline salt being shaken in a vial with about an equal quantity of rectified spirit of wine; the two liquors separated on standing for a moment; the spirit rising to the top, and the alcaline solution collecting itself at the bottom, both of them transparent as at first. When some sea-salt was dissolved along with the alcali, the spirit produced an opake milkiness in the lye; and on standing for a few minutes, a saline matter separated and fell to the bottom; sometimes in a powdery, and sometimes in a fair crystallized form. Solutions of the *American* and my own Potashes being examined by this method, a saline matter was thrown down from all of them, from A A in small quantity, from B and G in a very large one. It was hoped that these salts were no other than the pure marine or other foreign salts contained in the Potashes, which might thus be at once separated and collected by themselves: but it was found on many trials, that they always retained a very consider-

able portion of alcali. When only fea-falt and falt of tartar were diffolved together, the falt precipitated from the folution by fpirit of wine was not pure fea-falt; it had little of the true muriatic tafte, the alkali feeming to prevail; it did not decrepitate, or but very flightly, in a red-hot iron ladle; and its quantity appeared much greater than that of the fea-falt employed. Saturated folutions even of alcaline falt and fea-falt, mixed together in equal quantities without any other addition, grew milky and thick, and threw off a large portion of cryftalline falt fimilar to the foregoing; of the fame kind alfo was great part of the falt obtained by cryftallization from the *American* Potafhes. It is not neceffary in this place to inquire into the caufe of the fingular feparations which happened in thefe experiments: Thus much only it imports the affayer to know, that when Potafh contains marine or other foreign falts, a ftrong lye of the Potafh will grow milky, and depofite a precipitate on adding about an equal meafure of rectified fpirit of wine; and that according as the marine falt is in greater or lefs quantity, the precipitate alfo will be more or lefs copious.

If a lye made from Potafhes be fully faturated with pure aqua fortis, minute portions of fea-falt may be difcovered in it by the common method with folution of filver, or, what will anfwer as well, folution of lead. But as all common fpring waters contain marine falt enough to turn milky with thefe folutions, all Potafhes muft be expected to do the fame. Indeed, if the folution of lead was made always exactly of the fame ftrength, and the lye made from the fame quantity of Potafh with rain or fnow water; as the exiftence of marine falt in the lye

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would be known by its turning the ſolution of lead milky, and precipitating the metal; ſo the quantity alſo of the marine ſalt might be eſtimated from the quantity of the lye neceſſary to precipitate all the lead from a certain determinate weight of the lead ſolution. But a proceſs of this kind would be greatly too troubleſome and tedious to be propoſed for a trial of Potaſhes.

The quantity of marine or other foreign ſalts in potaſhes is inveſtigable in another way. The ſtrength of lyes, or the degree of their impregnation with ſaline matter, may be judged by a method already familiar to the workmen, and which I have therefore taken no ſmall pains to improve, both in point of accuracy and convenience. The quantity of pure alcaline ſalt we ſhall likewiſe find means to determine with exactneſs. If then the one trial ſhews, that any Potaſh contains, for inſtance, fourteen ounces of ſaline matter in the pound, and the other that it contains but twelve ounces of pure alkali in the pound; we may conclude, I imagine ſatisfactorily enough, that the quantity of foreign ſalt in the pound amounts to two ounces.

Hydroſtatic aſſay of the ſtrength of lyes, and of the quantity of ſaline matter contained in Potaſhes.

THE quantity of ſalt in ſaline ſolutions is eſtimated, from the exceſs of the weight of a certain meaſure of the liquor, above that of an equal meaſure of common water. On this principle, the ſoapboilers and others judge of the ſtrength of lyes by weighing a quantity of the lye in a narrow necked bottle. A ſet of weights

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is made on purpofe for this ufe, called carats or cadukes. The bottle being tared and filled with water, the weight of the water is divided into two equal parts, and a weight made equal to one of thefe is marked 64; by continuing the divifion are obtained the weights, 32, 16, 8, 4, 2, 1 carats; fo that a carat is the 128th part of the weight of the water. Another weight is made which counterpoifes the bottle when filled with water; fo many carats as the bottle filled with lye weighs more than this water-poife, fo many carats ftrong the lye is faid to be. A fully faturated folution of pure acaline falt is about fixty-four carats, or half as heavy again as water; but the ftrongeft lyes commonly made for foapboiling or other purpofes, do not amount to half that weight; and hence the fixteen carat weight, with the four fubdivifions of it, are fufficient for common ufe.

It would be much more convenient and expeditious to weigh the bottle in the lye. The trouble of emptying and filling the narrow mouthed veffel is thus avoided: The bottle is eafier cleaned on the outfide than within; it is not needful to wait, as in the other way, till the lye fettles fine; and as there is much lefs weight upon the beam, the balance will turn with much greater nicety.

Either the foapboilers bottle, or a common vial, about the fize called four ounce vials, may be eafily fitted up for being weighed in lyes. The vial is to be loaded with fhot, fo that when corked it may fink in ftrong lye. Thruft a large pin through the cork, from below upwards, that the head may prevent it from being drawn out; and bend the pin, at the top, that it may hang

on a hook at the bottom of one of the ſcales of a balance. To keep the cork from being penetrated by the lye, it may be dipt in melted white wax, and hung by the fire, that as much as poſſible of the wax may ſoak in; after which, the wax that may remain on the outſide is to be wiped off clean with a cloth.

Though a common vial may thus eaſily be fitted up at any time by the operator himſelf; yet glaſs bubbles, where they can be procured, ſuch as are commonly uſed in hydroſtatical experiments, are preferable; as being of greater accuracy, and equal convenience. To the knob or loop of the bubble tye a piece of fine braſs wire, about two inches long, with a loop at the top to hang on the hook of the ſcale.

About the middle of the pin or wire, by which the inſtruments are hung to the ſcale, a mark is to be made, by flattening them a little with a blow of the bec of a hammer. For holding the liquor to weigh them in, there ſhould be a glaſs veſſel of ſuch ſize, that they may be wholly immerſed to the mark, without touching the bottom, and that they may hang clear of the ſides. Weigh them firſt in water; and make a weight, which, being put in the oppoſite ſcale, ſhall counterpoiſe them as they hang in the water, taking care that the ſurface of the water come juſt to the mark on the wire or pin; then wipe them dry; and having hooked them on the ſcale again, weigh them as they hang in the air. So much as they weigh more than the above water-poiſe, will be the weight of a quantity of water equal to them in bulk; and by dividing this weight, a ſet of carat weights may be made in the ſame manner as for the ſoapboiler's bottle. So

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many of thefe carats as are neceffary in the fcale over the vial or bubble to make them fink to the mark in any given lye, the waterpoife being in the oppofite fcale, fo many carats ftrong the lye is. I made a fet of carat weights for the foap-boilers narrow-necked fquare bottle, for a common four ounce vial, and for a glafs bubble; and on examining the fame lye, with each of the inftruments, found that all the three gave exactly the fame ftrength.

The common hydrometer is much more convenient in ufe than any of the above inftruments, but it is alfo much lefs accurate. A ftem of any moderate length does not admit of a fufficient number of diftinct divifions, fo that in fuch an extent of ftrength as from water up to ftrong lye, it can diftinguifh only very grofs differences. I have therefore endeavoured to improve this inftrument, and bring it in fome meafure to the accuracy of the bubble, by ufing a fcale and weights inftead of the divided ftem.

This hydrometer confifts of a hollow copper ball, at leaft two inches in diameter, with a ftiff piece of copper or brafs wire paffed through it, not above $\frac{1}{12}$th of an inch thick; the wire is foldered tight to the ball, and projects about two inches above, and three below it. On the top of the ftem or upper portion of the wire, is fixed a thin concave brafs plate for a fcale; and on the bottom of the wire is fcrewed a leaden or rather brafs bullet, of fuch weight as to fink the inftrument in water to a mark made about the middle of the ftem; being then put into a lye of the ftrength of eight carats, the weight neceffary in the fcale on the top to fink it in this lye was marked 8, from which all

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the other carat weights were eafily made. The inftrument being afterwards examined in different lyes, was found to correfpond exactly with thofe above defcribed. The diftance of the weight at bottom from the ball, keeps the inftrument from tipping with the weights on the top; and the flendernefs of the ftem renders a minute variation in the gravity of the liquor very fenfible: lefs than a quarter of a carat finks the whole length of the ftem, or two inches, fo that the inftrument will rife or fink above a quarter of an inch of the ftem by a difference of lefs than a thirty-fecond part of a carat. The tin cafe, which ferves both for keeping it in, and for holding the liquor to be tried with it, is a little fhallower than the height of the hydrometer itfelf, that the fcale may never fink fo low as to be wetted. The quantity of liquor ufed every time fhould be fuch, as to rife nearly to the top of the cafe when the hydrometer is immerfed. It will be convenient to have a mark in the fide, at the height where this quantity of liquor rifes to before the inftrument is put in.

As the carat weights fhew only the comparative ftrength of lyes, not their actual ftrength or the quantity of falt contained in them; I contrived a fet of weights on another principle. Some pure falt of tartar is melted in an iron ladle, that all remains of watery moifture may be expelled from it. An ounce of the falt, weighed out while warm, is diffolved in fifteen ounces of water. The weight which finks the hydrometer in this folution is marked 1 oz. By doubling this, is made the weight 2 oz. and by dividing it 8, 4, 2, 1, drams. So that the weight or weights neceffary to fink the inftrument in any given lye, exprefs

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at once the ounces and drams of ſalt which a pound of the lye contains. If the water, in diſſolving the ſalt, received no augmentation of its bulk, or if equal additions of ſalt gave equal augmentations; weights made in the above manner, would ſhew always the exact quantity of ſalt in the liquor, from the weakeſt up to the ſtrongeſt lye. On trial with different lyes of known ſtrengths, ſo far as the above ſet of weights reaches, which is as far as the higheſt carat weights uſed in buſineſs, it appeared, that they come ſufficiently near the truth for any common purpoſes, though not to minute exactneſs; and that the further they are carried beyond the above limits, the ſtrength expreſſed by them varies more from the real ſtrength of the lye; as if the fourth ounce increaſed the hydrometric weight leſs than the third; and the fifth ounce leſs than the fourth.

To aſcertain this point, a great number of experiments were made, many of which ſerved only to ſhew the irregularities to which trials of this kind are ſubject, and the difficulty of attaining to phyſical preciſion; ſome of them however appeared deciſive. A glaſs bubble hung by a horſe-hair in a quantity of water equal to four times its bulk, was counterpoiſed by a weight in the oppoſite ſcale, and 120 grains of ſalt of tartar made by myſelf were diſſolved in the liquor; the proportion of ſalt to the water was nearly as 1 to 48. If the water received no augmentation of bulk, the bubble would have loſt in this ſolution $\frac{1}{4}$ part of 120, viz. 30 grains; but it loſt no more than $24\frac{3}{4}$. If the augmentation of bulk proceeded uniformly according

to the quantity of ſalt added, it would have loſt 24½ grains more on every ſucceſſive addition of the ſame quantity: but the loſs continually diminiſhed, ſo far as the experiment was carried, the numbers correſponding to ſeven ſucceſſive quantities being 24½, 24, 23½, 22, 22, 21, 20. Eight times 120 grains were then added at once. The loſs of the bubble correſponding to this quantity was 144 grains, or 18 at a medium for every 120. So that the larger the quantity of ſalt, the leſs was the ratio of the increaſe of the weight, and the greater was the ratio of the increaſe of the volume.

It appears therefore, that for making an hydroſtſtatic aſſay of Potaſh, the quantity of ſalt in the liquor ought to be ſmall. When only one part of alcali was diſſolved in 63 parts of water, little or no augmentation could be perceived; the actual loſs of the bubble, in four times its bulk of the liquor, being almoſt exactly one fourth part of the whole quantity of ſalt diſſolved. Mr. *Eller*, in a paper on the ſolution of ſalts in the *Berlin* memoirs, obſerves alſo, that water diſſolves $\frac{1}{64}$ its weight of alcaline ſalt without having its bulk increaſed. This proportion therefore may be fixed upon as a ſtandard, and within this latitude we need not be afraid of any ſenſible error.

To make the aſſay weights, half an ounce of pure ſalt of tartar, perfectly dried, as already mentioned, by melting in an iron ladle, is diſſolved in 63 half ounces of water; and the weight which ſinks the adjuſted vial, or the bubble, or the hydrometer in this lye, is marked 16, denoting, that 16 ounces in the pound, or the whole

quantity

quantity of the matter added to the water, is pure ſalt. From this weight are made, by diviſion, the weights 8, 4, 2, 1, $\frac{1}{2}$, $\frac{1}{4}$: ſo that if a lye be made from any Potaſh with the above proportion of water, the weights neceſſary to ſink the inſtruments in the lye will expreſs the ounces of pure ſalt, which a pound of the Potaſh contains.

Theſe weights may be uſed alſo, where great exactneſs is required, for trying the ſtrength of the ſtrongeſt lyes as well as of weak ones. A weighed quantity of the ſtrong lye being put into a convenient veſſel, and the hydrometer immerſed, pour in water till the inſtrument ſinks to the proper mark with the 16 weight in the ſcale. The liquor is then to be weighed again, to find the quantity of water added. So many times as this water exceeds the weight of the lye, ſo many ounces of ſalt are contained in ſixty-four ounces of the lye, or ſo many quarters of an ounce in the pound.

To make the lye for the aſſay of Potaſh, the half-ounce of powdered Potaſh is to be ſhaken with the ſixty-three half-ounces of water, or rubbed in a mortar, that the ſalt may be fully extracted: or the Potaſh may be boiled with a little of the water; the clear part poured off into a tared glaſs, in which there ſhould be ſome cold water to keep it from cracking; the undiſſolved part of the Potaſh boiled with a little more water, and put to the reſt; and the whole quantity made up with cold water to thirty-two ounces: for the greater convenience, the liquor ſhould always be weighed in the ſame veſſel, and one weight kept for its tare.

As different waters differ ſomewhat in gravity, it will be proper to try the inſtruments occaſionally in water alone, that allowance may be made, in caſe the water uſed in the aſſay ſhould prove heavier or lighter than that which the inſtrument was adjuſted with. It does not appear that common waters affect the gravity of the lye any otherwiſe than in proportion to their own gravity. An hydrometer was adjuſted ſo as to ſink to the mark in rain-water, which had been caught in a clean veſſel in an open plain: ſalt of tartar being then diſſolved in the water in the ſtandard proportion, the weight which ſunk the hydrometer in the ſolution was marked 16, and divided into aſſay-ounces as above deſcribed. In one of the heavieſt pump-waters I could meet with, the ſame inſtrument required an additional weight of one aſſay-ounce to ſink it; and in a ſtandard lye made with this water, it required alſo exactly one ounce more than the ſixteen.

The effect of heat in varying the gravity of the liquor, is not only more conſiderable, but leſs uniform. Some ſtandard lyes being heated, and a thermometer and hydrometer immerſed in them, and examined from time to time as the liquors cooled; it appeared, that while the thermometer ſunk from 80 to about 60 of *Fahrenheit*'s ſcale, the hydrometric weight varied near 3 aſſay-ounces; but in an equal interval below 60, it did not vary above half ſo much. There are two ways of avoiding any errors from this cauſe; one is, to make the aſſay-lye always with cold water from a well or ſpring; for it appears that ſpring-waters,

as they iſſue from the earth, are, in different climates and different ſeaſons, nearly always of the ſame temperature; viz. about 48 or 50 of *Fahrenheit*'s thermometer; and happily about this degree of warmth, a variation of ſeveral diviſions of the thermometer ſcarce ſenſibly affects the gravity of the lye. The other way is, to make the aſſay-lye by boiling the Potaſh with a part of the water, as above mentioned; hanging a thermometer in the liquor, and waiting till it has always fallen to the ſame degree of heat, before aſſaying it with the hydroſtatic inſtruments, which in this caſe muſt have their weights adjuſted to that ſtandard degree.

The thermometer muſt be a mercurial one: there is no occaſion for its reaching higher than about 100 degrees of *Fahrenheit*'s ſcale; but the diviſions ſhould be large, that the ſtandard degree may be the more eaſily and exactly diſtinguiſhed. It is to be hung with its ball in the liquor; a cylindric glaſs, about 3½ inches wide in the inſide, and 7½ deep, affords convenient room both for it and the hydrometric inſtrument at the ſame time.

This proceſs diſcovers the quantity of ſaline matter in the Potaſh with ſufficient nicety. To determine whether this ſalt be the pure alcali which it ought to be, recourſe muſt be had to operations of a different kind, ſuch as that deſcribed in the following article.

Aſſay of the quantity of pure alcaline ſalt contained in Potaſhes.

THE true ſtrength of potaſhes, as it depends on their quantity of pure alcaline ſalt, muſt be eſtimated from characters which belong to alcaline ſalts only; among which, the neutralization of acids is one of the chief. Several perſons have, on this principle, endeavoured to aſcertain the comparative ſtrength of different Potaſhes, but not their abſolute ſtrength; nor do they ſeem to have always attended to certain circumſtances neceſſary for the accuracy of the experiment.

If the whole ſubſtance of the Potaſh is uſed for mixture with the acid, a conſiderable error may ariſe from the earthy part; for the earthy matter in genuine potaſhes, or lime, or vegetable aſhes fraudulently mixed, will ſaturate a portion of acid, as well as the true alcaline ſalt. The ſalt muſt therefore be ſeparated from the earth, by ſolution in water and filtration.

The quantity of acid, neceſſary for the ſaturation of the lye, ſhould be determined, not by drops or tea-ſpoonfuls, but by weight; and the point of ſaturation, not by the ceaſing of the effervеſcence, which it is extremely difficult, if not impracticable, to hit with tolerable exactneſs, but by ſome effect leſs ambiguous and more ſtrongly marked, ſuch as the change of colour produced in certain vegetable juices, or on paper ſtained with them.

The finer ſort of purpliſh blue paper uſed for wrapping ſugar in, anſwers ſufficiently well for this

this purpofe; its colour being changed red by flight acids, and afterwards blue or purple again by flight alcalies. What I have chiefly made ufe of, and found very convenient, is a thick writing paper ftained blue on one fide with an infufion of lacmus or blue archil, and red on the other by a mixture of the fame infufion with fo much dilute fpirit of falt as is fufficient juft to redden it. The paper is wafhed over with a brufh dipt in the refpective liquors, two or three times, being dried each time, till it has received a pretty full colour, and afterwards cut in flips a quarter of an inch or lefs in breadth; a bit of the end of one of the flips being dipt in the liquor to be tried, the red fide turns blue while any of the alcali remains unfaturated, and the blue fide turns red when the acid begins to prevail. If either the acid or alcali confiderably prevails, the paper changes its colour immediately on touching the liquor: if they prevail but in a low degree, the change is lefs fudden. The part dipt is always to be cut off before a frefh trial.

The acid I have employed is fpirit of falt; which was preferred to the other mineral acids, on account of its having no action upon the marine falt contained in the Potafhes. The moft convenient method I could contrive of managing the procefs for an affay of Potafh, is the following.

Two drams avoirdupois, or $\frac{1}{8}$ of an ounce, of pure falt of tartar, perfectly dried by fufion in an iron ladle, as already mentioned, are to be diffolved in an ounce or two of water; it

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will be proper to have for this ufe a cylindrical glafs veffel about 6 inches deep and $2\frac{1}{2}$ wide.

Take a quantity of fpirit of falt, and dilute it with 10 or 12 times its meafure of water; fill with this mixture a vial that will hold fomewhat more than 4 ounces of water: the vial which I find moft commodious is nearly of the fhape of an egg, with a broad foot that it may ftand fure, a funnel-fhaped mouth for the convenience of pouring the liquor into it, and a kind of lip or channel at one fide of the mouth, that the liquor may be poured or dropt out without danger of any drops running down on the outfide. Hook the vial, by means of a piece of brafs wire tied round its neck, to one of the fcales of a balance; and counterpoife it, while filled with the acid liquor, by a weight in the oppofite fcale.

Pour gradually fome of the acid from the vial into the folution of falt of tartar, fo long as it continues to raife a ftrong effervefcence; then pour or drop in the acid very cautioufly, and after every fmall addition, ftir the mixture well with a glafs cane, and examine it with the ftained papers. So long as it turns the red fide of the paper blue, more acid is wanted: if it turns the blue fide red, the acid has been overdofed. That there may be means of remedying any accident of this kind, without being obliged to repeat the whole preceding part of the experiment, it will be proper to referve a little of the alcaline folution in another vial: this is always to be added towards

wards the end, and waſhed out of the vial with a little water.

When the liquor appears completely ſaturated, making no change in the colour of the paper, hook the vial on the ſcale again, to ſee how much it wants of its firſt weight: this deficiency will be the quantity of the acid liquor conſumed in ſaturating the two drams of alcaline ſalt. So much as this quantity wants of four ounces, ſo much, in proportion, of common water muſt be added to all the reſt of the acid mixture. If for inſtance the quantity conſumed in the ſaturation is three ounces, then, for every 3 ounces, or 3 pounds, or 30 pounds, of the acid liquor, muſt be added one ounce, or one pound, or ten pounds of water; the acid will thus be ſo adjuſted, that four ounces of it will ſaturate two drams of alcali: it will be expedient to make another trial, to ſee whether it is exactly of this ſtrength.

The apparatus being thus prepared, the aſſay of Potaſh is made as follows.

LET two drams of the powdered Potaſh be boiled for a minute with about an ounce of water: after ſtanding a moment to ſettle, pour off the clear part into a ſmall filter of paper, fitted into a wire funnel ſupported by its rim in the cylindric glaſs. Boil the remainder of the Potaſh with as much more water; and when the firſt lye has paſſed through, pour this into the filter, waſhing out the whole with a little freſh water; when all the liquor has run through the filter, which it will

do in a ſhort time, pour in a little water, to waſh out what ſalt may remain both in the paper, and in the undiſſolved earthy matter of the Potaſh; when this has dropt through, a little more water may be added, till the drops that fall from the filter make no change in the colour of the red paper. This part of the operation is leſs tedious in practice than it may ſeem to be in the deſcription; and the aſſayer may eaſily contrive, where diſpatch is neceſſary, to have a number of theſe lyes preparing at the ſame time.

Charge the vial with the adjuſted acid mixture, and counterpoiſe it with a weight in the oppoſite ſcale. Pour the acid into the lye as above mentioned, till the mixture makes no change in the coloured papers; and weigh the vial again, to ſee how much of the acid has been conſumed. Four times this quantity of pure alcaline ſalt is contained in every pound of the potaſh.

To avoid any little embarraſſment or error, that may ſometimes happen, even in this ſmall degree of calculation; the four ounce weight may be marked XVI, the two ounce VIII, the one ounce IV, the half-ounce II, the quarter of an ounce I; the two drams 8, the one dram 4, the half-dram 2, and the quarter of a dram 1. By this means the weights in the ſcale will always expreſs at once the ounces and drams of alcali contained in a pound of the potaſh.

A perſon accuſtomed a little to this operation, will be able to determine by it, not

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only the quantity of pure alcali, but whether the alcali has any injurious cauſticity. Plain alcalies efferveſce with the acid, from almoſt the firſt drop, till the ſaturation is completed: thoſe which are fully cauſtic, make no effervefcence at all; and thoſe which are cauſtic in part, do not begin to efferveſce, till a conſiderable quantity of the acid has been added, more or leſs according to the degree of cauſticity.

As acids, added to potaſh in ſubſtance, act upon its earthy part as well as its alcaline ſalt, I was led to make ſome trials of an acid already ſaturated with earth. Among the natural or artificial compounds of this kind, the bitter ſalt, prepared from the bittern of ſea-water, promiſed beſt. It was hoped that the proceſs would thus be conſiderably abridged, and no more be needful than to boil the two drams of Potaſh with two or three ounces of water, for a minute or two, and add ſome adjuſted ſolution of the bitter ſalt, till the red papers dipt in the milky mixture juſt ceaſed to be turned blue. It appeared, that for many ſorts of Potaſhes this ſimple proceſs would anſwer ſufficiently well; but that caſes may occur in which it would be extremely fallacious. If the Potaſh contains quick-lime, the bitter ſolution will act upon the lime, as well as on the alcaline ſalt. And indeed, if this did not happen, the quick-lime, remaining after the ſaturation of the alcali, would give an impregnation to the liquor not eaſily diſtinguiſhable from that of the alcali itſelf. I therefore forbear giving any detail of

the experiments made on the above principle; and apprehend that the methods of trial already recommended, by the hydroſtatic inſtruments and acid ſpirits, will ſatisfactorily determine the quality of any kind of Pot-aſhes.

FINIS.